The Effects of Manure at Saline Soil on Growth, Dry Matter Production and Crude Protein of Sesbania grandiflora

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The Effects of Manure at Saline Soil on Growth, Dry Matter Production and Crude Protein of *Sesbania grandiflora*

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Abstract

Saline soil is one of major abiotic stress in Indonesia. The research was conducted to evaluate growth, dry matter production and crude protein of *Sesbania grandiflora* at saline soil with different application dosage of manure. The research was done during June – December 2016at saline soil (EC = 4.1 dS/m) in Kaliori sub-district area, Rembang Regency, Central Java Province, Indonesia. The treatments were dosage of manure (0, 10 and 20 tonnes/ha). *Sesbania grandiflora* was planted as sole legume and inter-planted with *P. maximum.*Parameters measured were plant height, number of leaves, dry matter production and crude protein at first cutting and second cuttings. Results showed that plant growth was higher with application manure at saline soil. The effect of manure was obvious at second cutting. The highest dry matter production was obtained at application 20 ton/ha manure. Application manure at saline soil affected crude protein of *S. grandiflora* at first cutting. Manure was not affected crude protein *S. grandiflora* at second cutting. The conclusion was application of 20 ton/ha manure at saline soil (EC = 4.1 dS/m) increased growth, dry matter production and crude protein of *Sesbania grandiflora.*

1. Introduction

Saline soil is one of major abiotic stress in Indonesia. Excess salt, especially sodium chloride (NaCl) on the saline soil will cause ionic stress and osmotic stress [17]. Sodium (Na) and Chloride (Cl) are not essential for plant, therefore accumulation of these specific ions can be directly toxic for plants. The ability of plant to absorb water will reduce because of osmotic stress. Osmotic stress is similar to drought stress. Both ionic stress and osmotic stress will decrease plant growth. The effect of drought stress on *Oryza sativa* has been associated with the reduced chlorophyll content, number of tillers, stover yield and grain yield [8]. Plant ttolerance to soil salinity is varied. *Sesbania grandiflora* was the most tolerant crops on saline soil than *Leucaena leucocephala*,*Centrosema pubescens*, *Caliandra calothyrsus* and *Crotalaria juncea* in saline soil with electrical conductivity (EC) of 11 dS/m [5]. Biomass production of *Sesbania* has shown promisingly on moderately saline sodic soil among the forage species [9]. *Sesbania grandiflora* could be grown as sole crop or mixed cropping.

The negative effects of saline soil are intensified by the low levels of soil organic matter. Low organic matter at saline soil will reduce biological activity. The role of nitrogen becomes crucial at saline soil because of biological activity of saline soil is poor. A number of organic N-containing materials, such as animal manure, sewage sludge and plant residues are being used as soil amendments and a sources of N for improving the saline soil quality [18]. The research was conducted to evaluate growth, dry matter production and crude protein of *Sesbania grandiflora* at saline soil with different application dosage of manure.

2. Materials and Methods

2.1. Study area

The research was conducted at saline soil in the Kaliori sub-district area, Rembang Regency, Central Java Province, Indonesia (July– December 2016). Annual rainfall was 1140 mm year^{-1}. Soil pH, C-organic, total nitrogen and cation exchange capacity were 7.8 (alkaline), 1.08% (low), 0.13% (low) and 11,99 cmol/kg (low), respectively. Eelectrical conductivity (EC) was 4.1 dS/m. According to saline soil classification [1], saline soil at that area classify as moderately saline

2.2. Design and treatments

The experimental design was a randomized complete block design (RCBD) with three blocks. The treatments were dosage of manure (0, 10 ton/ha and 20 ton/ha). Cow dung was used as manure. *Sesbania grandiflora* was planted as sole legume and inter-planted with *P. maximum*. The size of each plot was 6 m x 7 m. As sole legume, *Sesbania grandiflora*was planted at 100 cm x 75 cm. In inter-planted, *S. grandiflora* was planted between *P. maximum* rows that planted at 100 cm x 75 cm. *S. grandiflora* and *P. maximum* were planted at the same time. The planting materials wereseed for *S. grandiflora* and tillers for *P. maximum.* Anorganic fertilizer was applied with recommended dosage of nitrogen (60 kg N/ha/cutting), phosphorus (150 kg P_2O_5/ha) and potassium (100 kg K_2O/ha). *S. grandiflora* was cut at 13 weeks after planting. The second cut was done 7 (seven) weeks after first cut. *S. grandiflora* was cut at 30 cm above soil.

Parameters measured were plant height, number of leaves, dry matter production and crude protein. One hundred grams of fresh forage yield was dried at 105^{o}C until the weight of sample was constant to measure dry matter percentage. Crude protein and crude fibre was determined using the procedure of the Association of Official Analytical Chemists (AOAC, 1984). Data obtained were analyzed using analysis of variance, followed by Duncan Multiple Range
Test (DMRT) to compare the difference between treatments [12].

3. Results and Discussion

3.1. Plant Growth

Application manure on saline soil increased ($p < 0.05$) plant height and leaf number of *S. grandiflora* at first cutting and second cutting. Growth of S. grandiflora was significantly lower without manure (0 ton/ha). There were no significant difference ($p > 0.05$) between application 10 ton/ha and 20 ton/ha manure on growth of *S. grandiflora*. Growth of S. grandiflora when planted solely and when inter-planted with P. maximum were not differed ($p > 0.05$) at the same dosage of manure at saline soil (Table 1).

Plant growth was higher with application manure at saline soil. Manure can be function both as organic fertilizer and soil amendment. There are many beneficial effects of organic fertilizer as soil amendment such as soil biological and physical properties improvement and slow release of nutrients [3]. Organic amendments reduced the salt content at saline soil. This condition will improve the content of nutrient available at saline soil such as the availability of nitrogen (N), phosphor (P) and potassium (K) [16]. Potassium is one of essential nutrient for plant. The function of K is to maintain plant turgor pressure or osmotic pressure. Low osmotic pressure of saline soil with application of manure will increase absorption of water. Application manure at saline soil increased C-organic, organic matter, cation exchange capacity and potassium exchange [2].

Table 1. Plant height (cm) and number of leaves of *Sesbania grandiflora* at different dosage of manure

Manure		Plant heigh (cm)		Number of leaves	
		1st Cutting	2nd Cutting	1st Cutting	2nd Cutting
0 ton/ha	Sole legume	55.5[b]	153.2[b]	48.8[c]	165.0[b]
	Inter-planted	60.5[b]	113.7[b]	66.7[bc]	143.3[b]
10 ton/ha	Sole legume	105.6[a]	233.7[a]	139.8[ab]	306.3[a]
	Inter-planted	119.7[a]	222.6[a]	176.3[a]	345.3[a]
20 ton/ha	Sole legume	111.4[a]	248.4[a]	150.5[a]	346.7[a]
	Inter-planted	101.1[a]	227.1[a]	146.2[ab]	293.0[a]

Values within columns having the same superscript are not significantly different (P<0.05) using Duncan Multiple Range Test

3.2. Dry matter production

Dry matter production of *S. grandiflora* at saline was increased at treatment of 10 ton/ha and 20 ton/ha organic fertilizer both planted solely and inter-planted with P. maximum (Figure 1). An increase in DM production of S. grandiflora when planted solely at first cutting, from 0.97 ton/ha to 2.15 ton/ha and 2.38 ton/ha, as organic fertilizer increased from 0 ton/ha to 10 ton/ha and 20 ton/ha. The production of S. grandiflora when inter-planted with P. maximum were 1.08, 2.08 and 2.59 ton DM/ha for organic fertilizer application at 0, 10 and 20 ton/ha respectively. Dry matter production of S. grandiflora was 45 – 259 g/m^2 or 72.99 – 194.36 g/plant at first cutting. That production was higher than those reported by [15] whose reported dry matter production of S. grandiflora was 68 g/plant. Application of organic fertilizer increased significantly dry matter production of S. grandiflora at saline soil. The lowest dry matter production of *S. grandiflora* at first cutting was at no organic fertilizer treatment both planted solely and inter-planted with *P. maximum*.

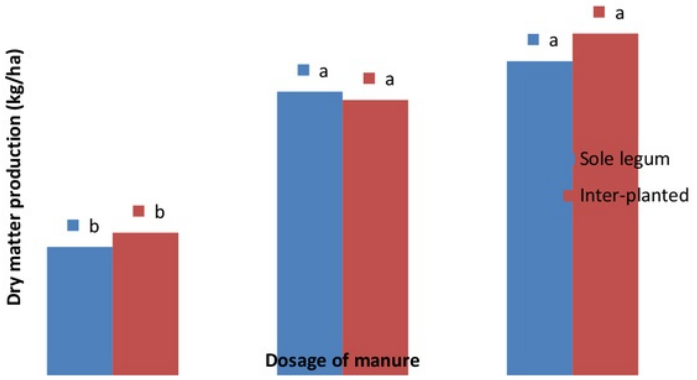

Figure 1. Dry matter production of *Sesbania grandiflora* at first cutting

The effect of manure was obvious at second cutting. The highest dry matter production was obtained at application 20 ton/ha manure (Figure 2). Manure as organic fertilizer release nutrient slowly, so the availability of nutrient increase time by time. Application of manure increased nitrogen availability. Total N at saline soil was 0.05 g/100 g soil. Application of manure at saline soil increased total N 60 to 90 % or 0.38 -0.55 g/100 g soil [19]. The influence of soil salinity on the decomposition of organic matter and nitrogen mineralization in animal manure amended soils. The amount of CO2-C released from animal manure amended soils was found to be increased at an increasing rate as incubation progressed [14]. Saline soil showed significantly ($P \leq 0.05$) low $NH4^+$-N content compared to the non-saline soil. The release of N-NH4 in the saline soil with the addition of manure is significantly higher than without manure (control treatment). The content of $N\text{-}NH_4$ in the control was 2 - 13 mg / kg of soil

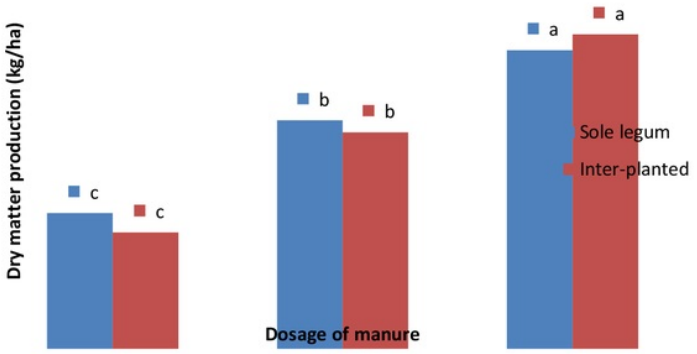

Figure 2. Dry matter production of *Sesbania grandiflora* at second cutting

3.3. Crude Protein

Application manure at saline soil affected significantly ($P< 0.05$) crude protein of *S. grandiflora* at first cutting. Manure was not affected crude protein *S. grandiflora* at second cutting (Table 2). Crude protein content of *S. grandiflora*was varied between 19.1 % - 25.6 % at first cutting, 23.3 % - 27.0 %. 2.3 % - 27.0 % at second cutting. These values were lower than the value of 33.78% reported by [6] for fresh leaf of *S. grandiflora* from Calcutta. However, that crude protein was higher than those reported by [7] and [11]. Crude protein recorded 23.3 % [7] and 23.1 % [11], respectively.

Application of manure at saline soil will decrease soil salinity. Application of manure to saline soil caused an increase in cation exchange capacity (CEC) greater adsorption of cations such as potassium, calcium and magnesium than sodium (Na^+). Conversely, Na+ leaching and a lower exchangeable sodium percentage (ESP) will decrease with addition of organic amendments [4]. Increased soil salinity at no manure treatment decreased crude protein of *S. grandiflora* at first cutting. Application manure did not affected crude protein at second cutting. Higher soil salinity affected several forage quality, such as organic matter (OM), crude protein (CP), neutral detergent fibre (NDF) and in vitro gas production. Generally, higher salinity level led to higher nutritional quality, although their significance varied amongst species and cuttings [10]. Iincreased electrical conductivity or salinity did not affected crude protein [13].

Table 2. Protein of leaves *Sesbania grandiflora* at different dosage of manure

Manure		Crude Protein (%)	
		1st Cutting	2nd Cutting
0 ton/ha	Sole legume	19.1[c]	27.0
	Inter-planted	22.0[b]	26.9
10 ton/ha	Sole legume	23.0[a]	26.3
	Inter-planted	25.6[a]	25.1
20 ton/ha	Sole legume	25.5[a]	23.3
	Inter-planted	25.4[a]	25.7

Values within columns having the same superscript are not significantly different (P<0.05) using Duncan Multiple Range Test

4. Conclusion

Application of 20 ton/ha manure at saline soil (EC = 4.1 dS/m) increased growth, dry matter production and crude protein of *Sesbania grandiflora.*

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